Applying a Modular, Layered Approach to

Troubleshooting Tape Drive Hardware

In storage environments, tape drives and libraries can be cost-effective backup and restore devices, but they may incur support costs for troubleshooting and maintenance. This article introduces a modular, layered approach that can ease system administration of tape devices by methodically troubleshooting problems to determine root causes and resolve issues.

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In the typical enterprise data center, tape drives, tape libraries, and other tape automation devices can be cost-effective workhorses for offline data storage. However, the total cost of ownership for the many tape devices attached to a data center's servers can escalate when support and service costs are factored into the equation. Given these considerations, administrators must take a proactive approach to troubleshooting, determining root causes, and correcting problems.

A basic system for troubleshooting tape drive devices can be categorized in a four-layer stack, similar to a TCP/IP stack. As shown in Figure 1, the predominant layers include the hardware layer, the BIOS layer, the OS layer, and the application layer.

Although the hardware layer and the BIOS layer can be combined into a single layer, various troubleshooting techniques can be carried out independently on each of these layers. This article provides details and troubleshooting techniques for the four layers.

Troubleshooting at the hardware layer

The scope of the hardware layer extends from the tape drive to the SCSI cable connectivity of a SCSI controller. Loose cable connections can cause problems at this layer. Administrators can perform the following troubleshooting procedures to diagnose tape device problems at the hardware layer:

- Check for improper SCSI termination, which can lead to SCSI errors during backups or to the tape

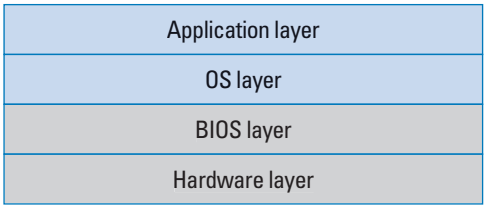

Figure 1. Layered model for modular approach to troubleshooting

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device not being detected on the BIOS level.

- Check that the SCSI installation is properly configured—terminators must exist at both ends of the bus. Most host bus adapters (HBAs) are terminated by default, so be sure that the last device in the chain is also terminated.[1]
- Determine how the SCSI device is terminated. Some SCSI devices are internally terminated, which can be disabled through a jumper or a dual in-line package (DIP) switch, while others use an external terminator plug.

Tape drives and libraries usually perform a power-on self-test (POST) operation, in which the system initializes itself and initiates an internal self-test to check for hardware issues. Some tape drives and tape libraries have a display panel, which provides a hex code that corresponds to the hardware error that occurred within the system. The hex code may indicate a self-diagnostic mode or a particular display of blinking or colored lights. Consult the device documentation for more information.

Troubleshooting at the BIOS layer

If a tape drive is not detected on the BIOS level of a controller, the problem usually resides in the controller or the tape drive. Administrators can perform the following troubleshooting procedures to determine why a tape drive is not being detected:

- Change the SCSI ID of the tape drive or library to determine whether the SCSI ID is causing the problem. For example, the tape drive's SCSI ID could conflict with a device on the same SCSI bus, which usually occurs when the SCSI ID of the tape drive is 7—the default SCSI ID of the HBA (SCSI controller). When attaching a tape drive with a SCSI ID above 7 on a narrow SCSI channel, change the SCSI ID to a value below 7.
- Check all the other devices in the SCSI chain. If one of the devices on the same SCSI bus is not responding, it should be separated from the SCSI bus.
- Check the compatibility matrix of the tape drive to determine whether the controller is supported. Commonly used HBAs in Dell™ servers include the Adaptec SCSI Card 39160 and SCSI Card 29160 and the LSI Logic LSI53C1030 embedded SCSI controller.
- Check for incompatibility between standards. For example, if a tape drive is connected to a narrow SCSI channel controller, the narrow SCSI channel can support only seven SCSI IDs.
- Check the configuration of the SCSI host adapter and ensure that the SCSI Disconnection and Parity settings are enabled. Synchronous Negotiation should be disabled. The SCSI transfer rate should be set to 5 Mbps.[2] If hard drives are being duplexed, both SCSI cards should be configured identically.
- Make sure that the SCSI card is set to use Edge Triggering and not Level Triggering. Level Triggering involves the use of shared interrupts, which can cause problems in some systems.

Troubleshooting at the OS layer

If the tape drive is detected on the BIOS level, it should also be detected on the OS level. To facilitate device detection, administrators should proactively check with hardware vendors for updated device drivers.

A basic system for troubleshooting tape drive devices can be categorized in a four-layer stack. The predominant layers include the hardware layer, the BIOS layer, the OS layer, and the application layer.

Microsoft Windows OS

The Microsoft® Management Console (MMC) provides a user interface through which administrators can coordinate systems management for Microsoft Windows® environments. In the Computer Management > Device Manager menu, administrators can view all hardware components within the Windows-based environment. From this menu, they can check whether a tape device is listed. The "?" icon beside a tape device indicates that the device driver is not loaded for that particular device. Device drivers usually can be downloaded from the vendor's Web site or from the CD provided by the vendor.

Novell NetWare OS

System administrators managing systems within Novell® NetWare® environments can troubleshoot tape hardware from the command-line interface. To check whether a tape drive is listed in NetWare, administrators should issue the following command:

```
list storage adapters
```

Sample output of the preceding command is shown in Figure 2.

[1] If both internal and external devices are attached to one host adapter, it may be necessary to disable the termination on the adapter card if it is physically located in the middle of the bus.

[2] Different host adapters will set these parameters in different ways. Some utilize jumpers or DIP switches, while others use a software-based configuration utility. Not all host adapters will be capable of adjusting all of these parameters.

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The following command will list only the devices attached to the system:

```
list devices
```

Sample output of the preceding command is shown in Figure 3.

If the device cannot be viewed on the OS level, administrators should issue the following command to scan all the SCSI buses:

```
scan for new devices
```

In the device list output, the NetWare OS may not list the tape drive with its actual name or it may list the tape drive as an "unbound device object." In such cases, a proper compatible driver should be loaded so that the output will reflect the inquiry name of the tape drive. The common device driver for all tape devices is nwtape.cdm. For Digital Linear Tape (DLT) tape devices, the common driver is dlttape.cdm.

If the SCSI card is enabled for logical storage units (LUNs), the changer and tape drive may be using the same SCSI ID but different LUNs. If so, administrators must enable LUN support. For example, if using an Adaptec SCSI card, the administrator would add `LUN_ENABLE=FF` to the line that is loading the driver for this card in startup.ncf:

```
LOAD AHA2940.HAM SLOT=HBA slot number LUN_ENABLE=FF
LOAD SYM8XXNW.HAM SLOT=HBA slot number /LUN
```

```
NW2600:list storage adapters
   0x00 [V100-A100] USB UHCI Controller [slot 0]
   0x01 [V025-A0] Novell ATA/IDE Host Adapter Module [slot 10008]
      0x07 [V025-A0-D0:0] SAMSUNG CD-ROM SN-124 N104
   0x02 [V358-A1] LSI_53C1030:10023 [slot 10023]
      0x0E [V358-A1-D6:0] Unbound Device Object
      0x0B [V358-A1-D0:0] FUJITSU MAP3367NC rev:5608
      0x0C [V358-A1-D1:0] FUJITSU MAP3367NC rev:5608
      0x0D [V358-A1-D2:0] FUJITSU MAP3367NC rev:5608
   0x03 [V358-A2] LSI_53C1030:10024 [slot 10024]
   0x04 [V321-A3] Adaptec SCSI Card 39160/3960D - Ultra160 SCSI [slot 201]
   0x05 [V321-A4] Adaptec SCSI Card 39160/3960D - Ultra160 SCSI [slot 202]
      0x0A [V321-A4-D4:0] DELL     PV-132T          227D
      0x09 [V321-A4-D1:0] IBM      ULTRIUM-TD2      37RH
   0x06 [V024-A5] Legacy FLOPPY Controller [slot 0]
      0x08 [V024-A5-D1:0] Legacy Floppy
```

Figure 2. Sample output for Novell NetWare command to list storage devices

```
NW2600:list devices
0x0007: [V025-A0-D0:0] SAMSUNG CD-ROM SN-124 N104 [CD]
0x0008: [V024-A5-D1:0] Legacy Floppy [FLOPPY]
0x0009: [V321-A4-D1:0] IBM      ULTRIUM-TD2      37RH [TAPE]
0x000B: [V358-A1-D0:0] FUJITSU MAP3367NC rev:5608 [HDD]
0x000C: [V358-A1-D1:0] FUJITSU MAP3367NC rev:5608 [HDD]
0x000D: [V358-A1-D2:0] FUJITSU MAP3367NC rev:5608 [HDD]
0x000E: [V358-A1-D6:0] Unbound Device Object
```

Figure 3. Sample output for Novell NetWare command to list devices attached to the system

Linux OS

In Linux, /proc/scsi/scsi is the file that shows the inquiry string for the tape drive. The /var/log/dmesg file will have an entry for the tape drive after the kudzu utility is executed and the device driver of the controller is loaded. If a tape library has a changer module and the tape drive and changer have the same SCSI ID but reside in different LUNs—which can occur on Dell PowerVault™ 122T autoloaders with DLT VS 80 technology—the Linux kernel will not update the /proc/scsi/scsi file with the inquiry string. In this case, system administrators should update the file with the following command:

```
echo "scsi add-single-device 2 0 0 13" >
   /proc/scsi/scsi
```

In the preceding command, the four numbers refer to the HBA ID (2), the SCSI bus (0), the SCSI ID (0), and the LUN (13). Devices in Linux are referenced by a device file. A device file can be a raw device file or a logical device file. Because a tape drive is a sequential device, it can be referenced using a raw device path.

The Dell support Web site (support.dell.com) provides numerous tools to help troubleshoot hardware-related tape device issues. Administrators also can initiate a self-diagnostic test to obtain an error code and messages on the front panel of the tape device. The user guide of the tape device can then provide additional information about the error code and troubleshooting steps to help resolve the issue.

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Troubleshooting at the application layer

From the application layer, it is often difficult to drill down to the root cause of problems because most applications do not interact with the hardware directly. Application software generally communicates with the device drivers through the OS kernel, and the device drivers communicate with the firmware of the storage unit. Some applications may have native device drivers loaded to communicate with storage units. Administrators can perform the following troubleshooting procedures to diagnose tape device problems at the application layer:

- Check for wear and tear of the Linear Tape-Open (LTO) tape drive, which can prevent tape media from being populated to maximum capacity.
- Clean the tape head using a cleaning cartridge if a significant amount of debris has accumulated on the head. Media debris can prevent data from being written to a tape cartridge.
- Check whether the device is supported by the application and whether the appropriate device drivers have been installed if the tape hardware is not detected on the application level but is detected on the OS level.
- Check the vendor's Web site to determine whether an updated version of the tape device firmware is available if SCSI errors occur while backing up large amounts of data.[3]

Software vendors typically provide diagnostic utilities to aid in hardware troubleshooting. For example, VERITAS NetBackup software includes a utility through which administrators can initiate a self-diagnostic confidence test on the tape device.

Troubleshooting other general operational issues

Tape drives can break down during a backup or restore procedure. In Windows, administrators would detect this error in a system event log; in Linux and NetWare, the error would appear on the system console or logger screen.

The Microsoft Management Console provides a user interface through which administrators can coordinate systems management for Microsoft Windows environments.

In some cases, to determine the root cause of a failure, administrators must take a SCSI trace and then analyze it on a SCSI analyzer. SCSI analyzers show time diagrams, command listings, and state listings. When using SCSI analyzers, administrators should be familiar with all the respective SCSI commands so that they can check the conditions and the trace communications over the SCSI bus.

System administrators managing systems within Novell NetWare environments can troubleshoot tape hardware from the command-line interface.

Whenever SCSI errors or hardware errors occur in the backup device, the target—the device that receives service requests for processing—sets a unit attention (UA) flag, which eventually follows a SCSI reset condition. Administrators can determine the cause of a SCSI bus reset by taking a SCSI trace of the communication path between the target and the initiator—a SCSI device containing application clients and SCSI ports that originate device service and task management requests to be processed by a SCSI target device. Obtaining the sense data information from the SCSI trace session can show which flags have been set and help administrators identify a clear path to problem resolution.

Efficiently resolving tape hardware problems

Administrators can enhance the process of troubleshooting tape devices by following the modular, layered approach described in this article. To determine root causes rapidly, administrators should first categorize the condition as a hardware issue or a software issue, then determine the layer at which to begin troubleshooting. This method can help administrators find an efficient path to problem resolution.

Gajanan Mudaliar is an engineering analyst on the tape storage engineering team in the Dell Product Group. His primary area of expertise is testing and troubleshooting tape hardware and automation devices. Prior to joining Dell, Gajanan had seven years of IT experience in technical support and system administration for enterprise storage installations. He has a B.E. in Electronics and Telecommunication from the University of Kolhapur in India.

FOR MORE INFORMATION

Dell support:
support.dell.com

VERITAS support:
support.veritas.com

[3] As a general safety rule, do not disconnect or power down the tape device during the firmware upgrade.

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